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DEVELOPMENT AND TESTING OF THE MAP INTERPRETATION, TERRAIN ANALYSIS, AND NAVIGATION AT NIGHT PROGRAM OF INSTRUCTION (MITANN POI)

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U. S. Army

Research Institute for the Behavioral and Social Sciences

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There is a critical requirement for conducting Army combat flight operations at terrain altitudes (including nap-of-the-earth (NOE)) at night. Current courses of instruction are inadequate in training for the accomplishment of that requirement. This report describes the development of a course that will provide instruction to assist in meeting that requirement. This course is developed to be a night navigation and map/terrain interpretation course using unaided (naked eye) and aided (Night Vision Goggles) vision techniques (MITANN). It includes the approach to the development of all

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course lecture,textual and visual materials; the testing and validation of those materials; and a transfer of training effectiveness investigation.

Results of the transfer of training effectiveness from MITANN to inflight performance showed that the group which received MITANN training (Experimental Group) navigated at night along an NOE route with significantly more accuracy than the Control Group. This increase in accuracy was accompanied by a reduction (although not significant) in the time it took to fly the route. These results indicated that MITANN was successful in training the critical aspects of night NOE navigation.

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FOREWORD

The Fort Rucker Field Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences provides timely support to the U.S. Army Aviation Center (USAAVNC) through research and development efforts to enhance aircrew training and performance. One portion of these efforts has been directed toward improving tactical night terrain flight capabilities. The research efforts reported here are in response to Human Resources Need (HRN) RCS CS GPA-1337, Tactical Terrain Flight Technology Studies.

This research was conducted under Contract No. DAHC19-77-C-0008, Human Factors Research in Aircrew Training Performance Enhancement, by Canyon Research Group, Inc.

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This research was conducted under Contract No. DAHC19-77-C-0008 by Canyon Research Group, Inc. with Mr. Charles A. Gainer, Chief, US Army Research Institute Field Unit serving as the Contracting Officer's Technical Representative and Dr. Michael G. Sanders serving as the technical point of contact. Mr. Douglass R. Nicklas and Dr. George D. Siering, Canyon Research Group, Inc., served as Program Manager and Principal Investigator, respectively, during this research.

The author wishes to express his appreciation to the following persons whose invaluable contributions made the success of this project possible. Major Paul B. DesJardins and Mr. Charles E. Carr, ARI, who served as the aircraft pilots for this research; Dr. Brian D. Shipley for his assistance in the statistical design; Mr. Daniel T. Wick for his assistance in the data analysis; Dr. Garvin L. Holman, Dr. John W. Ruffner, Dr. George D. Siering, Mr. Colin D. Ciley, and Mrs. Tina Pridgen who provided continuing suggestions and critical editing advice, and the Subject Matter Experts and Scheduling support provided by the Department of Flight Training (DOFT), Fort Rucker, Alabama.

Development and Testing of the Map Interpretation, Terrain Analysis, and Navigation at Night Program of Instruction (MITANN POI)

Brief

Requirement:

Analyses of operational requirements and training materials indicated that one of the most formidable tasks confronting the Army aviator was navigating at nap-of-the-earth (NOE) altitude at night. Analysis of existing coursework identified the need for additional training aids and supplemental teaching materials to teach the skills necessary for NOE flight and navigation at night. Therefore, the requirement existed for coursework oriented specifically toward teaching night flight and navigational skills at NOE altitude using aided (Night Vision Goggles) and unaided vision. The Map Interpretation, Terrain Analysis and Navigation at Night Program of Instruction (MITANN POI) was developed to fulfill this requirement.

Procedure:

The MITANN POI was developed using the systematic Instructional Systems Development (ISD) approach. A transfer of training effectiveness to the aircraft was accomplished to insure that MITANN taught the skills necessary for successful night NOE navigation.

Findings:

Results of the transfer of training effectiveness test showed that MITANN was effective in improving navigational skills during night NOE flight while using either aided (NVG) or unaided vision techniques. These results were particularly important because the improvement in navigational skills was over and above the skills that the subjects obtained previously in daytime terrain flight training.

Utilization of Findings:

The MITANN POI provides training managers with a self-contained, stand-alone program of instruction which contains all textual, lecture, and visual materials necessary for training night navigation at NOE altitudes. This program of instruction is immediately applicable to Initial Entry Rotary Wing (IERW) training, and is easily modified for use in the field units.

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INTRODUCTION

Modern weaponry has reached a level of sophistication such that any aircraft exposed to the enemy on the battlefield can be destroyed. However, aircraft survivability tests have proven that terrain flying can minimize the effectiveness of the enemy weapons systems. Flight at terrain altitudes, including nap-of-the-earth (NOE), has become the fundamental element for mission success in the high threat environment.[1] In addition, flight at terrain altitudes will be required twenty-four hours a day under all weather conditions.[2]

NOE flight is defined as flight at varying airspeeds as close to the earth's surface as vegetation, obstacles, and ambient light will permit. NOE flight in vegetated areas generally is flown at or below the tops of the vegetation.

Night flight at NOE altitude creates several problems for the aviators. NOE flight at night is mentally taxing and physically fatiguing. This, compounded by the fact that navigating at this altitude also is very demanding, makes the task of flying and navigating at NOE altitudes during periods of darkness and restricted visibility extremely difficult.

Modes of Operation in Night NOE Flight

The first step in satisfying the requirement to fly and navigate successfully at the lowest possible altitude at night is the effective use of available ambient light. Based on the level of ambient light, Army aviators have two modes of operation available to them. If ambient light levels are in the middle or high light levels (mid light level is the illuminance of night ambient light between 2.5×10^{-4} and 3.0×10^{-3} foot-candles; high level is 3.0×10^{-3} foot-candles and above)[3] the pilot may choose to fly using unaided vision techniques. When ambient light levels drop into the lower light levels[4] (below 2.5×10^{-4} foot-candles), the pilot can utilize the AN/PVS-5 Night Vision Goggles (NVGs), which provide a tremendously increased night vision capability. A description of the AN/PVS-5 NVGs is given at Appendix A.

The crucial significance of training and fighting in the nighttime environment has been emphasized in recent years by the Son Tay prison camp raid into North Vietnam, the successful rescue at Entebbe by Israeli troops, and the night crossing of the Suez Canal by Israeli armored units.[5] However, the full capability of the NVG is not being realized,

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[1]FM 1-51, *Rotary Wing Flight*. Washington: Department of the Army, April 1979.

[2]Bynum, J. A., Shipley, B. D., and White, W. C. *Helicopter Night Low Level Navig tion: Study 1-Checkpoint Identification*. Fort Rucker, AL: US Army Research Institute Field Unit, May 1976.

[3]FM 1-51, *op. cit.*, Ref. 1.

[4]FM 1-51, *op. cit.*, Ref. 1.

[5]Wood, William C. *Night Vision Goggles*. Fort Rucker, AL: US Army Aviation Digest, July 1978.

due, in part, to the lack of an adequate training program. One purpose of the present research was to develop such a training program.

Existing Programs of Instruction for Night NOE Flight and Navigation

The Army has developed two major Programs of Instruction (POI) for training NOE flight and navigation during daytime and night operations. One is the extremely effective Map Interpretation and Terrain Analysis Course (MITAC), and the other is the Night Hawk/Night Vision Goggle (NH/NVG) Exportable Training Package.

MITAC. MITAC is a 13-part course designed to teach Army aviators the technique and practice of map interpretation in planning and executing terrain flight operations. This course employs a multimedia approach using texts, lectures, 35mm slides, and 16mm motion pictures for use in both a traditional classroom setting and on an individual, self-paced basis.[6] This course, however, is designed only for daylight flight conditions.

Night Hawk/Night Vision Goggle Exportable Training Package.[7] The Night Hawk/Night Vision Goggle Exportable Training Package originally was designed for direct export to the field units; however, since much of its material was directly applicable to Initial Entry Rotary Wing (IERW) training, parts of this package have been integrated into the current IERW training program. Careful examination of this training program with repsect to the contents of the Night Navigation Planning Guide[8] indicated that the training program covers all aspects of night NOE flight for both aided (NVG) and unaided vision except night NOE navigation. This examination also revealed that the section of the Exportable Training Package dedicated to terrain analysis at night consisted only of a static (i.e., slide/lecture) presentation of night terrain analysis and contained no realtime dynamic materials (e.g., practical application movies).

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[6]McGrath, James J., and Foster, Edward A. *Development of a System of Aircrew Training in Nap-of-the-Earth Navigation.* Alexandria, VA: US Army Research Institute for the Behavioral and Social Sciences, January 1975.

[7]Night Hawk/Night Vision Goggle Exportable Training Package. Fort Rucker, AL: Directorate of Training Developments, January 1979.

[8]Harman, Joan. Night Navigation Planning Guide, Appendix C. In *Development of Improved Night Vision Goggles for Navigation and Flight in Low Level Light Environments* (Research Memorandum). Westlake Village, CA: Canyon Research Group, Inc., November 1978.

Requirements

It is apparent from an analysis of operational requirements and training materials that one of the most formidable tasks confronting the Army aviator is that of navigating at NOE altitude at night. Existing coursework requires additional training aids and supplemental teaching materials to teach the skills required for navigation at night. Therefore, a requirement exists for coursework oriented specifically toward teaching night navigational skills at NOE altitude using aided and unaided vision. This report describes the development and evaluation of such a course, the Map Interpretation, Terrain Analysis and Navigation at Night (MITANN) Program of Instruction (POI).

METHOD

During the development of the MITANN POI, training requirements were carefully analyzed to insure that the resulting course covered all of the tasks needed by the student to accomplish the desired learning outcomes of the course. In addition, efforts were directed to insure that MITANN contained only those materials that were absolutely essential for the accomplishment of these learning outcomes. The format for MITANN closely followed that of the successful daytime MITAC which was described earlier. MITANN was developed to contain all associated visual, textual, and lecture materials necessary to present the course training objectives in both unaided and aided (NVG) vision environments. MITANN was designed to be a self-contained, stand-alone program for use in IERW training and later, for exportation to the field units. The three-phase approach followed in the development of the MITANN POI is shown in Figure 1 and is discussed below.

Phase 1 - Development

The first step in the development of the MITANN POI was to gather and review information available from sources such as the scientific literature, technical specifications, existing coursework, and interviews with subject matter experts (SMEs). This effort resulted in the development of the Night Navigation Planning Guide.[9] The Planning Guide was further refined and assessed by SMEs and provided the training objectives of the course.[10] The initial course of instruction, achievement tests, and critiques subsequently were developed to address those objectives directly.

The initial MITANN POI was self-contained and stand-alone, and was written in a format similar to MITAC. The contents of the initial course included a night terrain interpretation program of instruction wich consisted of a static slide presentation emphasizing the differences between daylight and night with regard to terrain interpretation. Support materials included a Student Training Guide and supplement which correspond to the instructional program, and an Instructor's Guide, including lecture scenarios and supplementary references. Additional materials included handouts, map plates, answer sheets, a 50-item academic achievement test and critique. All of these materials were subsequently included in the comprehensive Night Hawk/Night Vision Goggle Exportable Training Package.[11]

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[9] Harman, Joan, *op. cit.*, Ref. 8.

[10] Harman, Joan. Training Objectives, Appendix D. In *Development of Improved Night Vision Goggles for Navigation and Flight in Low Level Light Environments* (Research Memorandum). Westlake Village, CA: Canyon Research Group, Inc, November 1978.

[11] Night Hawk/Night Vision Goggle Exportable Training Package, *op. cit.*, Ref. 7.

PHASE I - DEVELOPMENT

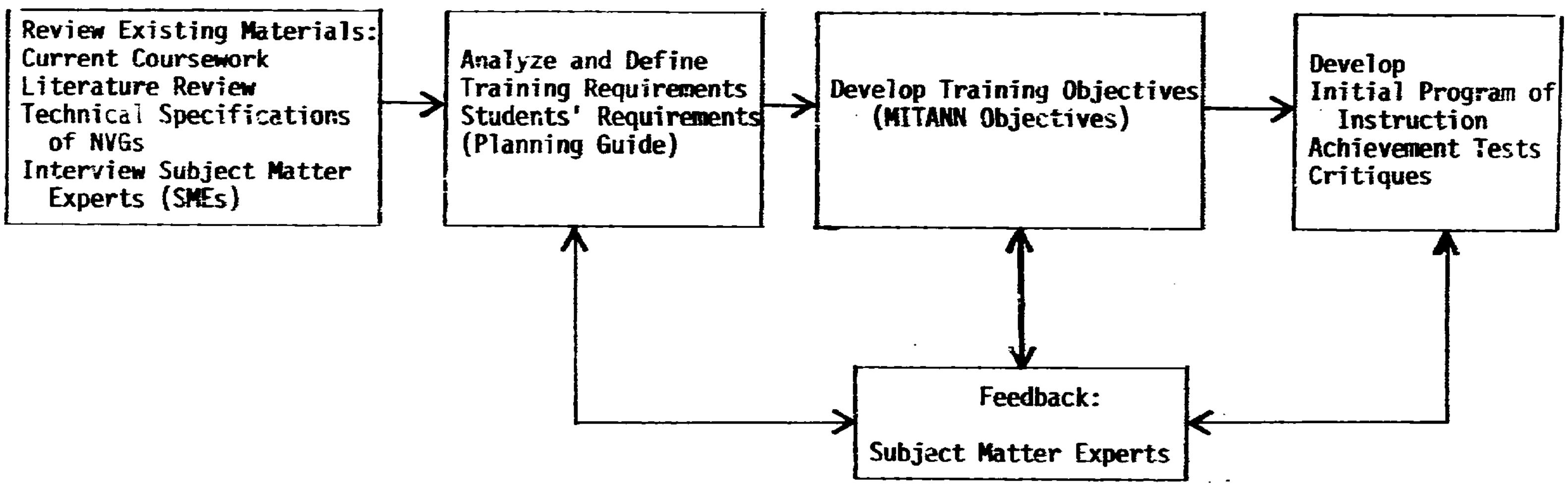
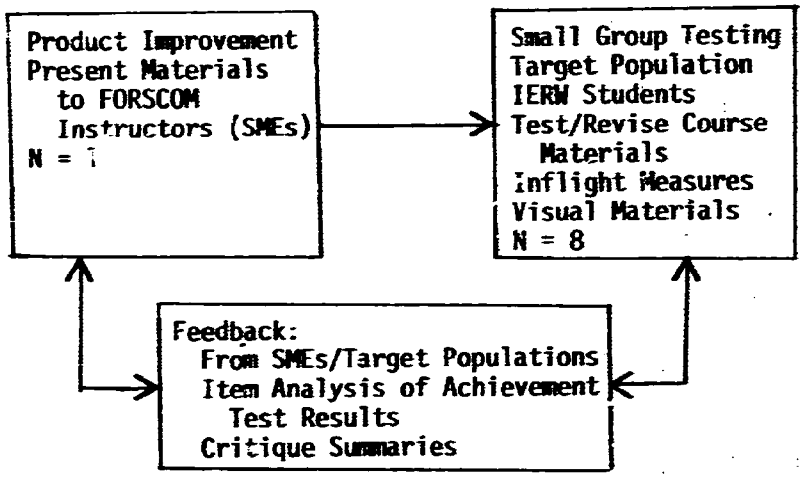


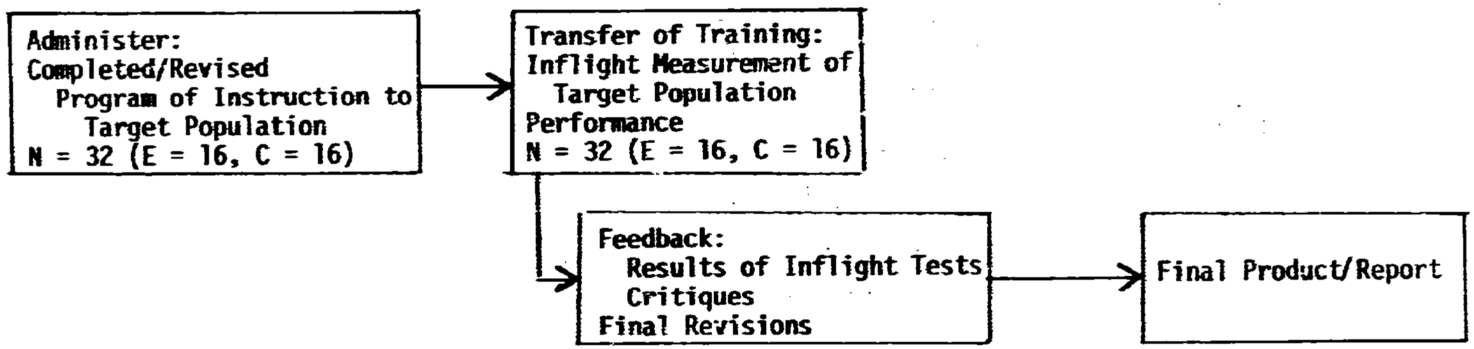
Figure 1. Three-phase approach for the development of the MITANN Program of Instruction

Figure 1 - Cont'd

PHASE 2 - UPDATE AND VALIDATION



PHASE 3 - TRANSFER OF TRAINING EFFECTIVENESS TEST



Phase 2 - Program Update and Validation

Program update and validation consisted of two related efforts which tested the effectiveness of the initial MITANN program of instruction. The first effort tested the Night Hawk/Night Vision Goggles Exportable Training Package. The second effort was a small group test designed as a pretest for the final transfer of training test. Taken together, these efforts provided the basis for improving the effectiveness of the initial MITANN POI. These related efforts are described in detail in the following sections of this report.

Product Improvement. The first step in updating and validating the course was accomplished using 16 experienced Forces Command (FORSCOM) instructor pilots attending the NH/NVG upgrade course as subjects. The 50-item academic achievement test was administered as a pretest (see Appendix B), followed by presentation of the academic portions of the NH/NVG Exportable Training Package in which the initial MITANN coursework was contained. The academic achievement test was then re-administered as a posttest. Results showed a significant increase ($p > .01$) from pretest scores ($\bar{X} = 69.5\%$) to posttest scores ($\bar{X} = 82.9\%$).[12] Critiques by these instructor pilots and item analyses of the academic achievement test provided the basis for updating the instructional materials as well as the academic achievement test.

The NH/NVG Exportable Training Package was designed to be used by experienced instructors. It contains a comprehensive listing of materials pertaining to night terrain flight, all of which are useful to IERW students, but it does not contain any dynamic practical application exercises. The effective use of such exercises had been shown in the MITAC program and, therefore, it was considered that such practical application exercises would likewise be beneficial not only for experienced aviators, but also for relatively inexperienced IERW student pilots.

Because of this need for practical exercises, efforts were carried out to convert daytime MITAC motion pictures into scenes that approximate what is seen at night. This was accomplished using black and white copies of MITAC films and reducing the level of the light projected through the use of a rheostat.

Inputs from FORSCOM instructors, critiques, and item analyses provided information for the revision of the course material. The addition of the practical application exercises led to the testing of this revised version of the course materials on a sample of the target population.

Small Group Testing. The small group test of the MITANN POI was designed as a pretest to the final transfer of training effectiveness test, to determine the feasibility of the overall program and to correct any inherent difficulties in the testing procedure prior to the final test.

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[12] Smith, Bruce A. *Testing of the Instructional Materials Contained in the Night Hawk/Night Vision Goggles Exportable Training Package (9400 Series)* (Working Paper). Westlake Village, CA: Canyon Research Group, Inc., May 1979.

Eight recent IERW graduates served as subjects in this test. Four subjects constituted the Experimental Group and were presented the course materials. The remaining four subjects constituted the Control Group. The Experimental and Control Groups were further divided into two subgroups for inflight testing. Using a 2 x 2 factorial design, one subgroup was tested for their ability to navigate using unaided vision techniques, and the other subgroup was tested using the NVG. Results of this testing are shown in the Results section of this report.

Several modifications were made to the course materials as a result of the small group test. Since the subjects in the target population of the small group test already had seen the MITAC films during the daylight presentation of that course, efforts were made to produce visual materials unfamiliar to future subjects. As a result of these efforts, films were developed from the unused portion of the advanced MITAC to serve as practical application exercises of night NOE flight that would be unfamiliar to the students. To insure that the visual materials did, in fact, depict actual night scenes, the resulting films were tested subjectively and objectively and were confirmed to be effective in the replication of actual night conditions.[13]

The resulting MITANN visual materials were designed to be suitable for use in three different classroom illumination levels, thus providing flexibility for instructing MITANN as the classroom situation dictates.

The first method is to have the students fully dark-adapt and view the visual materials at light levels which simulate night. This method allows the students to use the same visual processing (rods) as a pilot uses in the aircraft under night conditions. However, this demands a higher level of dark adaptation than is realistic for the navigator since the navigator will experience some deterioration in dark adaptation each time the map is referenced using a pen light flashlight. One disadvantage of this method is the length of time it takes to become fully dark adapted (30 to 45 minutes).

The second method is to have the students partially dark-adapt and view the visual materials at slightly higher light levels than the previous classroom situation. These higher light levels reduce the time to dark adapt to approximately 20 minutes and still provide illumination levels similar to night flight for the navigator. This method provides perceptual fidelity because the students utilize pen light flashlights for viewing the map plates and taking notes, in a manner similar to the procedures required for night navigation in the aircraft.

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[13] Hennessy, Robert T., Kelly, Gene, and Smith, Bruce A. *A Technique for Presenting Night Scenes Using Daylight Color Films* (Working Paper FR/FU 80-9). Fort Rucker, AL: US Army Research Institute Field Unit, in press.

The third method is to present the visual materials in a dimly lit classroom. This method provides enough light for such tasks as taking notes and plotting courses, and it eliminates the necessity for the subject to become dark-adapted. Since the subjects used for MITANN were severely limited with respect to available time, this third method was used to present the MITANN POI to the Experimental Group subjects.

The final MITANN POI resulting from the inputs described previously consisted of two independent but closely related instructional packages. One package was dedicated to unaided vision techniques and the other to aided vision (NVG) techniques. These two instructional packages can be taught either separately or conjunctively. In the IERW setting the materials comprising both modules were unfamiliar to the students, so they were taught conjunctively. In a field unit situation where there is some level of experience in both types of instruction, it remains the prerogative of the commander to choose to use either instructional package separately or in combination. A course outline of the final MITANN POI is given at Appendix C.

Phase 3 - Transfer of Training Effectiveness Test

The most appropriate time to present the MITANN POI in the IERW setting is immediately following the presentation of MITAC, which precedes night tactics flight training. Since the IERW training schedule restricted the use of subjects during this optimum training period, subjects for the transfer of training effectiveness test were selected as near to that optimum training period as the schedule would allow.

Subjects. Subjects for the transfer of training effectiveness test were 32 Warrant Officer Candidates and Commissioned Officers from classes 79/23-24 and 79/25-26 of IERW training at Fort Rucker, Alabama. They were at a point in their training one week prior to graduation. The selection of subjects from the same point in training provided a homogeneous subject group with respect to flying experience. All subjects had completed MITAC coursework successfully and total flight time ranged from 160 to 175 hours. The subjects were randomly assigned to either the Experimental Group or the Control Group.

Procedure. Because the MITANN POI consisted of two separate instructional packages, a 2 x 2 factorial design was utilized in the Transfer of Training Effectiveness Test (see Figure 2). The independent variables of this design were the type of academic instruction (i.e., Experimental vs. Control) and the type of vision technique (i.e., aided vision (NVG) vs. unaided vision).

		Inflight Test	
		Unaided	Aided (NVG)
Academics	MITANN (Experimental)	N = 8	N = 8
	No Course (Control)	N = 8	N = 8

Figure 2. Design for the MITANN Transfer of Training Effectiveness Test

Presentation of MITANN Program of Instruction. Five hours of instruction were conducted by an Army Research Institute (ARI) instructor pilot in two separate phases. The first phase of instruction was comprised of two one-hour phases which dealt with night map interpretation and terrain analysis, and night checkpoint identification. The second phase of instruction was comprised of three one-hour blocks which were based on practical application exercises of corridor tracking/communication, cross-course tracking and track testing. Training in both phases was divided equally between the NVG and unaided vision instructional packages. All subjects in the Experimental Group received training using both the NVG and unaided vision instructional packages. Each subject in the Experimental Group was pretested and posttested using the 50-item academic achievement test, and the entire course was critiqued following the inflight test. The Control Group also was tested using the 50-item academic achievement test.

In accordance with normal IERW academic procedures, the Experimental Group received the Student Study Guide and related reading assignments prior to the academic instruction. Since this material had a direct effect on the pretest scores of the Experimental subgroup, the data from these tests were not used for the comparison of those groups. Future plans call for these data to be used for test revision and improvement.

Instruction was presented in a classroom from which all external sources of light were blocked. The front of the classroom was draped with black cloth and visual materials were presented on a low reflectance black screen (reflectance ratio = 4.4%) using a projector modified with a rheostat to control the amount of light projected, thereby providing the desired night effect.

Ambient light levels in the classroom were controlled by the use of a desk lamp in the back of the room and illuminance was measured to be 1.0×10^{-1} foot-candles. The light level of the visual materials was controlled by using a projector modified by a rheostat. The light level was measured by a photometer to insure consistency. The brightest portions of the scenes measured 3.2×10^{-2} foot lamberts.

The first portion of each exercise was performed by the subject using unaided vision and the second portion of each exercise was performed using the NVGs. A desk lamp in the rear of the room provided sufficient light to allow the subjects to take notes and plot their courses. The desk lamp was not illuminated during the NVG portion of the course.

All tests, checkpoint answer sheets, and map plates were collected and later scored to provide an overall class grade. Student map plates were scored for Root Mean Square (RMS) error using the same procedures as described in the inflight test. It was anticipated that this grade would not only provide information on the student's progress in the class but that it would predict the inflight performance of the subject.

Inflight test. Following assignment to the Experimental and Control Groups, the subjects were divided randomly into two subgroups within the Experimental and Control Groups for the inflight testing (see Figure 2). One subgroup performed the inflight navigation task using aided vision (NVG), and the other subgroup performed the same inflight navigation task using unaided vision. All subjects navigated from the right front seat of a UH-1 helicopter. Instructor pilots for the inflight test were from the Army Research Institute (ARI) and were highly experienced in night NOE navigation.

Subjects in the aided vision subgroup navigated using the NVG in a hand-held position rather than strapping the NVG to their helmets because results of preliminary testing indicated that this was the most operationally feasible method of using the NVG to navigate.[14] This technique allowed the subjects to view the inside of the aircraft using unaided vision and flashlights, and it eliminated the focusing problems, the map reading difficulties, and reduced the fatigue of wearing the NVGs on the helmet. The instructor pilots flew the aircraft using unaided vision during all test flights.

The inflight test consisted of a night NOE flight along a 4-kilometer course. This course was a modification of NOE route #12 at Fort Rucker and is shown at Appendix D. Heading northwest, the course started in a heavily wooded creek bed, transitioned across a small ridge and continued over an area of flat terrain mixed with open fields scattered with foliage. Subjects used in the inflight test were screened to assure that they had not flown this particular course during IERW training. The subjects were required to provide all navigational instructions to the ARI pilot who was flying at NOE altitudes according to those instructions. Two UH-1 aircraft and two ARI pilots were utilized. One pilot flew the NOE route in one aircraft while the other pilot flew "cover" in the second aircraft as a safety measure.

Complete counterbalancing across all subgroups was done to reduce the possible effects of pilot/rater differences, winds, light levels, and route difficulty. Ambient light levels were measured during each

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[14]Smith, Bruce A. *Development of Improved Techniques for the Use of NVGs for Navigation and Flight in Low Level Light Environments* (Research Memorandum). Westlake Village, CA: Canyon Research Group, Inc., November 1978.

flight using a Spectra Pritchard photometer Model 1980A while the aircraft was on the ground in a remote landing zone. This was done to demonstrate that during the inflight test subjects from both the Experimental and Control Groups flew under equal light levels. The route was flown alternately in opposite directions to balance the effects of winds and to minimize the possibility that the subject in the cover aircraft might gain clues to the route of flight while flying in that role. Each of the two ARI pilots flew with equal numbers of subjects within each of the four subgroups.

Criterion measures. Inflight performance was measured by the subject's ability to navigate the course with respect to speed and accuracy. During the flight, the ARI pilot in the cover ship plotted the course actually flown by the subject's aircraft. Those subjects who deviated from the flight path by more than 500 meters from the course were considered to be lost and were returned to the last known point on the course prior to continuing. This plot of the resulting course, as flown by the subject's directions, was scored in the form of RMS error[15] on the basis of the resulting course's adherence to the designated course. RMS error was determined by dividing the course into 200-meter intervals and measuring the deviation from course at each of those intervals. RMS error is a measure of the average deviation from course, and it is weighted in such a manner that larger deviations are scored more critically than lesser deviations. For example, one 200-meter error is scored more critically than two 100-meter errors. Overall time to fly the route and light levels were measured by a researcher who was monitoring the flights on board the aircraft.

[15] Poulton, E. C. *Tracking Skill and Manual Control*. New York: Academic Press, 1974, pp. 34-35.

RESULTS

Phase 1 resulted in the development of an initial MITANN program of instruction. This initial draft of MITANN was included in the Night Hawk/Night Vision Goggle Exportable Training Package and consisted of the lectures, texts, static visuals (slides), 50-item academic achievement test and critique.

Phase 2 testing of the NH/NVG Exportable Training Package provided input for updating of the MITANN materials contained in that package. This resulted in further revision of the MITANN material already developed and the addition of practical application exercises consisting of black and white conversions of MITAC movies.

Further Phase 2 testing of a small group (N=8) of the intended target population resulted in the final version of the MITANN POI. This included the final revision of all of the MITANN instructional materials and the addition of new and unfamiliar practical application exercises. Data collected during the small group inflight test indicated that the MITANN POI was effective in teaching night NOE navigation, but that greater amounts of data were required to determine if this finding was statistically reliable. Inflight testing of this small group also provided information which was used to clarify ambiguities in the inflight testing procedures.

Results of the transfer of training effectiveness test in Phase 3, from MITANN to inflight performance, showed that the group that received MITANN training (the Experimental Group) navigated with significantly greater accuracy than the Control Group as measured by RMS error. This accuracy was accompanied by a reduction (although not statistically significant) in the time it took the Experimental Group to fly the route. It is also important to note that during the inflight test, four subjects in the Control Group deviated from the course by more than 500 meters, an indication that they were lost. None of the Experimental Group exceeded the 500-meter limit during the test. There were no significant interactions between treatments for either RMS error or time (see Tables 1 and 2).

To determine if the significance of the main effect was non-trivial, the index omega squared (ω^2) was calculated to determine the power of the effect of the association between academic treatment and route RMS error.[16] The independent variable of academic treatment accounted for a substantial portion (ω^2 = 10.1%) of the variance. This indicated a medium strength of the association between academic treatment and dependent measure of RMS error.[17] It can be concluded from the strength of the relationship that the treatment had practical significance in that the academic training resulted in a useful improvement in student pilot performance.

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[16] Meyers, Jerome L. *Fundamentals of Experimental Design* (2nd ed.). Boston: Allyn and Bacon, October 1975, 311-314.

[17] Cohen, Jacob. *Statistical Power Analysis for the Behavioral Sciences*. New York: Academic Press, 1977.

Table 1

Summary of the Analysis of Variance of RMS Error and Time Across Academic and Inflight Treatments

RMS Error		ss	df	MS	*f*
	Academics	12242.01	1	12242.01	4.394*
	Inflight Treatment	83.14	1	83.14	.030
	Academics x Treatment	560.82	1	560.82	.227
	Error	72436.52	26**	2786.02	
	Total	85322.49	29**		
Time					
	Academics	20.64	1	20.64	1.815
	Inflight Treatment	2.26	1	2.26	.20
	Academics x Treatment	11.16	1	11.16	.99
	Error	318.41	28	11.37	
	Total	352.47	31		

N = 32

*p = .046

**Two cases were missing due to IP scoring omission.

Table 2

Means and Standard Deviations of RMS Error and Time With Respect to Experimental and Control Groups

Academics	Inflight Treatment: NVG	Inflight Treatment: Unaided Vision
MITANN	RMS $\bar{X}$ = 81.75 σ = 46.51 N = 8 Time $\bar{X}$ = 12.15 σ = 4.24 N = 8 # who became lost=0	RMS $\bar{X}$ = 69.74 σ = 36.39 N = 7 Time $\bar{X}$ = 13.94 σ = 1.19 N = 8 # who became lost=0
No Course (Control)	RMS $\bar{X}$ = 114.06 σ = 68.26 N = 8 Time $\bar{X}$ = 14.93 σ = 1.70 N = 8 # who became lost=1	RMS $\bar{X}$ = 119.39 σ = 52.81 N = 7 Time $\bar{X}$ = 14.54 σ = 5.16 N = 8 # who became lost=3

The scores of the 50-item academic achievement test and the overall class grade (which consisted of a composite RMS score of the map plates) did not significantly correlate with inflight RMS accuracy or inflight time. These correlations are presented in Table 3.

Table 3

Correlation of Academic Achievement Test and Overall Class Grade With Inflight RMS Accuracy (N = 16)

Academic Score/Inflight RMS	$r = .06$
Class RMS/Inflight RMS	$r = .36*$
Academic Score/Inflight Time	$r = .29$
Class RMS/Inflight Time	$r = .02$

*$p = .11$

Analysis of variance of the photometer readings indicated that there were no significant differences across all cells with respect to ambient light levels. In addition, there were no significant correlations between ambient light levels and either inflight RMS score or the time it took to fly the route. These results are shown in Tables 4 and 5.

Table 4

Group Means for Inflight Ambient Light Levels Measured in Foot-Candles

	NVG	Unaided
MITANN	$\bar{X} = .0017$	$\bar{X} = .0035$
	N = 8	N = 8
No Course (Control)	$\bar{X} = .0013$	$\bar{X} = .0023$
	N = 8	N = 8

$p > .10$

Ambient light levels fell in the upper end of the middle light levels and, in one case, in the lower end of the upper light levels as defined by US Army Field Manual 1-51.[18]

Table 5

Correlation of Course Time and RMS With Ambient Light Level Readings

Time/Light Level	$r = .117$
RMS/Light Level	$r = .140$
$p > .10$	

[18] FM 1-51, *op. cit.*, Ref. 1.

DISCUSSION

The data clearly indicate that the MITANN POI was effective in improving navigational skills during night NOE flight while using either aided (NVG) or unaided vision techniques. These results were particularly important because the improvement in navigational skills attributable to MITANN were over and above the skills that the subjects previously obtained from MITAC. Since the possibility existed that the daytime MITAC generalized well to night flight, the increase gained from MITANN was a meaningful and practical improvement.

As stated previously, the optimum time to present the MITANN POI during IERW is immediately following presentation of MITAC and before night tactics flight training. Since the MITANN POI was tested using subjects who had five weeks more night flight experience than do students during the optimum training period, it can be postulated that students who receive this instruction during the optimum training period in IERW should gain even greater benefits. However, using subjects who were near IERW graduation provided a subject population with characteristics similar to those of new or transitioning pilots in a field unit. This suggests that MITANN would be effective in a field unit setting.

The use of an instructor to present MITANN who was generally unfamiliar with the contents of IERW academic coursework, and who was specifically unfamiliar with MITAC, suggests two important considerations. First, the present version of MITANN is directly applicable to the field because experience in teaching MITAC is not required to teach MITANN effectively. Second, the use of MITANN in IERW could be even more effective than indicated by available data, because IERW training in MITANN probably will be given by an experienced MITAC academic instructor.

The investigation of classroom measures determined that no singular measure significantly predicted inflight performance. However, since the correlation between class RMS score and inflight RMS approached significance ($p = .11$), RMS score is a measure that warrants further investigation.

It was expected that subjects who flew on the nights with higher ambient light levels would fly faster and more accurately due to the increased visibility. This was found not to be the case, as is indicated by the correlations shown in Table 5. Two possible explanations for this finding seemed to be related to the MITANN coursework. One, the subjects who flew in the higher ambient light levels could see the terrain more clearly and, in an attempt to be as accurate as possible, took more time to fly the route. Two, the fact that light levels had no real effect on RMS error was an indication that MITANN training provided some compensation for the subject flying under lower ambient light level conditions. An additional factor which may have contributed to this finding was the restricted range of light levels encountered during inflight testing.

Based on this research, several aspects of MITANN training require further research. MITANN is directly applicable to navigators in the field units and the mission of the OH-58 aeroscout helicopter in IERW, since the navigators in these situations fly in the right front seat. In IERW training, the navigator in the UH-1 aircraft flies in the jump seat. Further research is needed to determine the necessity of an adaptation of MITANN to train a navigator located in this position.

Because the Experimental Group subjects showed greater RMS accuracy and did not become lost, it is reasonable to judge that these student pilots were proficient in night NOE navigation when they were first tested in flight. However, student pilots trained at the optimum time in IERW will have less night flight time than the subjects used in the research reported here. Therefore, future research in night NOE navigation should quantify the night NOE aircraft time necessary after MITANN to produce IERW graduates who are proficient in night NOE navigation.

Critique results following the transfer of training effectiveness test were favorable with respect to all aspects of the MITANN POI (see Appendix E). Study, lecture and visual materials were rated as relevant and effective in teaching the objectives of night NOE navigation. It is important to note that the subjects found the overall course aided their performance in the inflight test and that the night film conversions were realistic.

REFERENCES

1. FM 1-51, *Rotary Wing Flight*. Washington: Department of the Army, April 1979.

2. Bynum, J. A., Shipley, B. D., and White, W. C. *Helicopter Night Low Level Navigation: Study 1-Checkpoint Identification*. Fort Rucker, AL: US Army Research Institute Field Unit, May 1976.

3. FM 1-51, *op. cit.*, Ref. 1.

4. FM 1-51, *op. cit.*, Ref. 1.

5. Wood, William C. *Night Vision Goggles*. Fort Rucker, AL: US Army Aviation Digest, July 1978.

6. McGrath, James J., and Foster, Edward A. *Development of a System of Aircrew Training in Nap-of-the-Earth Navigation*. Alexandria, VA: US Army Research Institute for the Behavioral and Social Sciences, January 1975.

7. Night Hawk/Night Vision Goggle Exportable Training Package. Fort Rucker, AL: Directorate of Training Developments, January 1979.

8. Harman, Joan. Night Navigation Planning Guide, Appendix C. In *Development of Improved Night Vision Goggles for Navigation and Flight in Low Level Light Environments* Research Memorandum). Westlake Village, CA: Canyon Research Group, Inc., November 1978.

9. Harman, Joan, *op. cit.*, Ref. 8.

10. Harman, Joan. Training Objectives, Appendix D. In *Development of Improved Night Vision Goggles for Navigation and Flight in Low Level Light Environments* (Research Memorandum). Westlake Village, CA: Canyon Research Group, Inc., November 1978.

11. Night Hawk/Night Vision Goggle Exportable Training Package, *op. cit.*, Ref. 7.

12. Smith, Bruce A. *Testing of the Instructional Materials Contained in the Night Hawk/Night Vision Goggles Exportable Training Package (9400 Series)* (Working Paper). Westlake Village, CA: Canyon Research Group, Inc., May 1979.

13. Hennessy, Robert T., Kelly, Gene, and Smith, Bruce A. *A Technique for Presenting Night Scenes Using Daylight Color Films* (Working Paper FR/FU 80-9). Fort Rucker, AL: US Army Research Institute Field Unit, in press.

14. Smith, Bruce A. *Development of Improved Techniques for the Use of NVGs for Navigation and Flight in Low Level Light Environments* (Research Memorandum). Westlake Village, CA: Canyon Research Group, Inc., November 1978.

15. Poulton, E. C. *Tracking Skill and Manual Control*. New York: Academic Press, 1974, pp. 34-35.

16. Meyers, Jerome L. *Fundamentals of Experimental Design* (2nd ed.). Boston: Allyn and Bacon, October 1975, 311-314.

17. Cohen, Jacob. *Statistical Power Analysis for the Behavioral Sciences*. New York: Academic Press, 1977.

18. FM 1-51, *op. cit.*, Ref. 1.

APPENDIX A

DESCRIPTION OF THE AN/PVS-5 NIGHT VISION GOGGLES

Night Vision Goggle Description

The first generation of Night Vision Goggles (NVGs) (SU-50) had a 60° field of view and was used mainly for limited search and rescue. The image resolution of this system (19-21 line pairs/mm) was less than that desired. Further technological advances improved the resolution of the image (24-28 line pairs/mm)[A-1] and made possible the development of the currently used AN/PVS-5 Night Vision Goggles.

The AN/PVS-5 NVG originally was designed for ground use and later adopted for use in flight. Subsequent flight evaluation has proven that NVGs provide an increased capability for terrain flight at quarter moon light levels and above.[A-2]

The AN/PVS-5 NVG is a self-contained binocular unit which consists of two identical monocular assemblies. These assemblies are mounted on an adjustable frame which allows the user to adjust for different inter-pupillary distances. Each monocular unit consists of an objective lens, an image intensifier assembly, and an eyepiece. A combination of headstraps is provided to facilitate wearing the goggles in several configurations (e.g., with the flight helmet, tanker's helmet, oxygen mask, or protective mask). The binocular assembly housing is constructed of a plastic material and is lined with a cushion which rests on the cheekbones. The entire unit is approximately 6-1/2 inches square, weighs 28 ounces, and provides a 40° field of view.[A-3]

[A-1] Stevenson, G. B. *Combat Air Vehicle Navigation and Vision (CAVNAV)*. Aberdeen Proving Ground, MD: US Army Land Warfare Laboratory, December 1973.

[A-2] Goff, G. W., Jr., and Harrison, R. L. *Improved Night Vision Goggles Customer Test*. Fort Rucker, AL: US Army Aviation Test Board, August 1978.

[A-3] FM 1-51, *Rotary Wing Flight*. Washington: Department of the Army, April 1979.

Figure A-1. Side and front view of the AV/PVS-5 Night Vision Goggles.

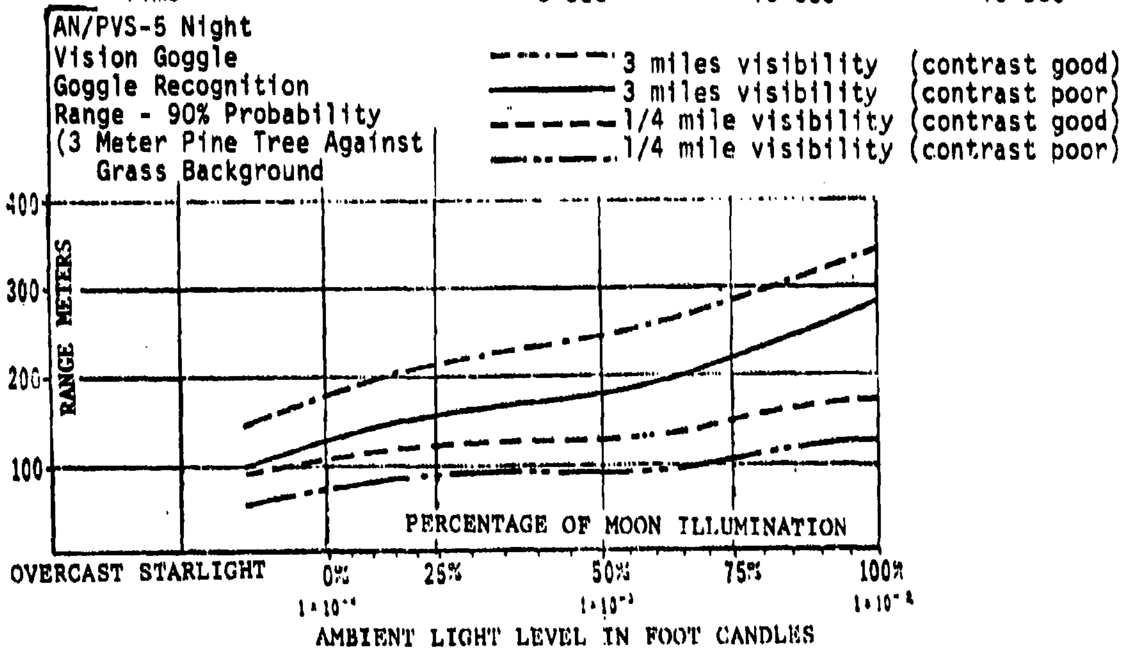
APPENDIX B

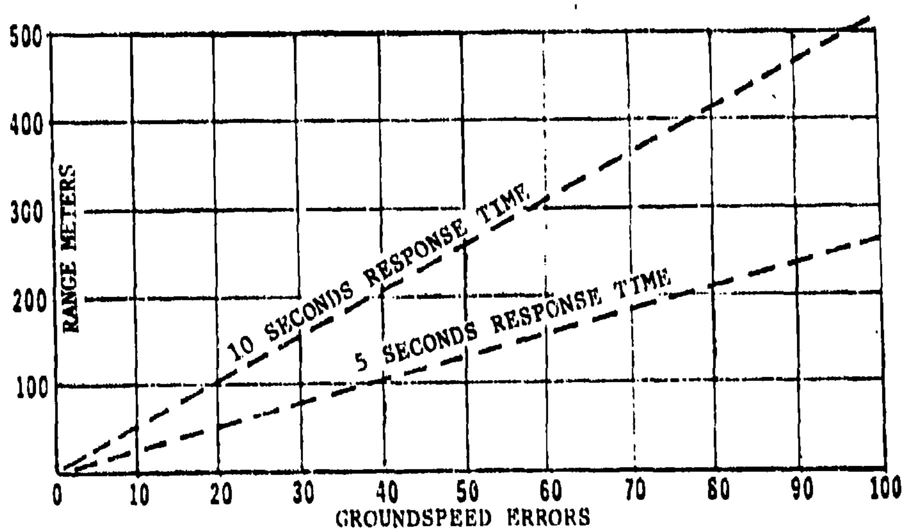
NIGHT HAWK/NIGHT VISION GOGGLE ACADEMIC ACHIEVEMENT TEST

NH/NVG ACADEMIC ACHIEVEMENT TEST

1 - 3 What is the maximum safe groundspeed for flight under each of the following conditions?

	Question 1	Question 2	Question 3
% Moon Illumination	25%	50%	100%
Visibility	3 miles (poor)	1/4 mile (good)	1/4 mile (poor)
Response Time	5 sec	10 sec	10 sec





1. a) 40 knots
   b) 50 knots
   c) 60 knots
   d) 70 knots

2. a) 25 knots
   b) 35 knots
   c) 45 knots
   d) 55 knots

3. a) 15 knots
   b) 25 knots
   c) 35 knots
   d) 45 knots

4. Which of the following is true concerning the infrared illumination (IR Position) on the Night Vision Goggles (NVGs)?

a) It is a trouble light for use during conditions of extreme
b) It has sufficient intensity for viewing objects over four meters away
c) The light from the illuminator can not be detected by the enemy using night vision devices
d) All of the above

5. Which of the following is <u>not</u> true concerning NVGs?

a) The NVGs can be adjusted to compensate for individual visual acuity differences
b) The NVGs can be focused from distances of 10 inches to infinity
c) Eyeglasses are not worn with NVGs
d) Astigmatism can be corrected through adjustment of the NVGs

6. The maximum safe groundspeed for flying with the NVG is based on

a) ambient light level.
b) visibility.
c) degree of contrast.
d) all of the above.

7. ________________ vision is experienced during daylight hours or when a high level of artificial illumination is present.

a) Photopic
b) Mesopic
c) Scotopic
d) None of the above

8. What is the cause of the central night blindspot?

a) The concentration of the rods in the fovea centralis
b) The concentration of the cones in the fovea centralis
c) The point where the optic nerve connects to the back of the eye
d) None of the above

9. Dark adaptation for optimum night visual acuity approaches its maximum level in approximately ________ minutes?

a) 30-45
b) 20-25
c) 15-20
d) 10-15

10. The NVG arctic adapter assembly for the battery is required for use when temperatures drop below ______.

a) 0° F
b) 50° F
c) 32° F
d) -20° F

11. What is the operational temperature range of the AN/PVS-5 NVG?

a) -65° F to 125° F
b) -50° F to 100° F
c) -65° F to 150° F
d) -50° F to 125° F

12. What is the minimum natural illumination that is acceptable for NVG training?

a) A minimum of .10 moon illumination
b) A minimum of .20 moon illumination and at least 40° moon elevation above the horizon
c) A minimum of .30 moon illumination and at least 10° moon elevation above the horizon
d) A minimum of .10 moon illumination and at least 30° moon elevation above the horizon

13. What is the anticipated life of the power source for the AN/PVS-5 NVG (at 70° F)?

a) 24 hours
b) 12 hours
c) 40 hours
d) 5 hours

14. If an emergency occurs during NOE flight, which of the following is true?

a) If it is an immediate action emergency (i.e., engine failure) no attempt should be made to remove the NVGs
b) If the emergency is not immediate action the removal of the NVGs is optional
c) The most important considerations are aircraft control and compliance with -10 emergency procedures
d) All of the above are correct

15. Which of the following statements is true concerning scotopic vision?

a) It utilizes the rods only
b) It requires daylight or a high level of artificial illumination
c) It provides for color vision perception
d) Both b and c

16. Dark adaptation is the process of increasing rod sensitivity and . . .

a) The time it takes to dark adapt varies with each individual
b) It is not affected by the amount of time spent in bright sunlight
c) It is not affected by diet
d) All of the above are true

17. Which of the following techniques is not recommended to protect your dark adaptation?

a) Wear red goggles where exposure to white light may occur on the ground
b) Avoid direct viewing of white light
c) Close both eyes when exposed to a white light source
d) Plan routes away from built up areas

18. Without supplemental oxygen, a measurable decline in night vision is evident at all pressure altitudes in excess of _____ feet.

a) 4,000
b) 10,000
c) 6,000
d) 8,000

19. Which of the following statements is <u>not</u> true concerning AN/PVS-5 NVGs?

a) They are a self-contained binocular image intensifier
b) They magnify the image that is seen
c) They are a high dollar item and should receive the same degree of security as M-16 rifle
d) All of the above are <u>not</u> true

20. A weak battery in the NVGs will be noted by which of the following?

a) Blinking image in one or both of the intensifier tubes
b) Failure of the IR illuminator
c) A dimming of the intensifier tubes
d) All of the above

21. The field of view (degrees) of the NVG is ________.

a) 20
b) 30
c) 40
d) 60

22. Which of the following is not true with regard to using NVGs during periods of restricted visibility?

a) The goggles degrade very little when viewing through thin obscurations
b) Halos around artificial lights are a cue to impending restrictions to visibility
c) The goggles can actually see through dense fog
d) There is an increase of "video noise" when restrictions to visibility increase

23. The degree of difficulty for night terrain interpretation is directly related to

a) Viewing distance
b) Flight altitude
c) Ambient light
d) Visibility restrictions

24. During terrain flight at night higher ambient light levels result in

a) Faster airspeeds and higher altitude requirements
b) Slower airspeeds and lower altitude requirements
c) Faster airspeeds and lower altitudes
d) Slower airspeeds and higher altitudes

25. Which of the following statements regarding night terrain interpretation is false?

a) The greater the viewing distance the harder an object is to identify
b) The higher the flight altitude the easier it is to identify terrain features
c) Lower visibilities make interpretation of the terrain more difficult
d) The smaller the viewing angle the harder an object is to identify

26. The AN/PVS-5 NVG focusing system is effective from a distance of

a) 10 inches to 4,000 feet
b) 10 inches to 2,000 feet
c) 2 meters to 4,000 feet
d) 10 inches to infinity

Questions 27 - 39 are true/false.

27. _____Roads are excellent checkpoints but they do not serve well as barriers.

28. _____A bridge can be useful as a navigational cue if it has vertical development.

29. _____Intersections are the most accurately plotted features on a standard military map.

30. _____Identification of intersections is fairly difficult during the day but easy at night.

31. _____Normally wires are impossible to see at night with or without NVGs.

32. _____Bodies of water appear rough and light in color and during low light levels provide high levels of contrast.

33. _____Open fields can be mistaken for bodies of water.

34. _____Bodies of water are not easily masked by terrain features.

35. _____Normally isolated fields can be recognized easily and related to the map.

36. _____Isolated or light color buildings provide poor navigational cues.

37. _____Most cemeteries in rural areas have light colored contrasting headstones which provide good orientation cues.

38. _____Low altitude flying does not allow for the use of silhouetting to enhance terrain interpretation.

39. _____Contrasts improve during the winter season because farms are barren of vegetation and snow covered.

40. Which of the following statements is true concerning terrain interpretation when flying in a desert area?

a) The texture and color of the soil does not provide any reflectivity
b) Visibility restrictions are more common than in forested areas
c) Flight altitude is normally lower and, thus, terrain recognition is improved
d) All of the above are true statements

41. Which of the following statements is true concerning terrain interpretation of flight over rolling terrain with heavy vegetation?

a) Terrain interpretation is difficult due to the lack of recognizable terrain features
b) Rivers and features which give distinct changes in elevation provide the best natural landmarks for navigation
c) Dirt roads and farm structures provide the most distinguishable artificial features
d) All of the above statements are true

42. Which of the following statements is <u>false</u> concerning terrain over mountains?

a) Airspeeds generally are faster due to rapidly changing terrain
b) Silhouetting ridgelines and other objects with vertical features against the skyline enhance recognition
c) Decreased ambient light can be expected in valleys and backsides of mountains
d) Contrast is poor where a heavy growth of vegetation exists in mountainous areas

43. The greatest source of natural ambient light is/are the

a) Stars
b) Moon
c) Reflection of ground lights off of clouds
d) Flares

44. A luminous phenomenon due to electrical discharge in the upper atmosphere which is most commonly seen in the high latitudes is an example of background illumination called?

a) Airglow
b) Aurora
c) Zodiacal light
d) Noctilucent cloud

45. The IR illuminator is effective for viewing within _____ meters.

a) 1
b) 2
c) 3
d) 4

46. What is the best you could expect your visual acuity to be during low-level light conditions (darkness)?

a) 20/200
b) 20/50
c) 20/20
d) 20/100

47. Required weather minima for NH/NVG flight along airways are _____ ceiling, _____ mile(s) visibility forecast for one hour before to one hour after training period.

a) 1000 ft, 1 mile
b) 1000 ft, 3 miles
c) 3000 ft, 1 mile
d) 3000 ft, 3 miles

48. Following an extended period of goggle use a color may overlay your vision. This is a very normal physiological effect called?

a) Night blindness
b) Astigmatism
c) Eye fatigue
d) After image

49. If you remove the NVGs and are in darkened surroundings you can expect to have full dark adaptation in _____ minutes.

a) 10-15
b) 5-10
c) 1-3
d) You are fully dark adapted while wearing NVGs

50. Which of the following is a problem associated with the use of NVGs?

a) Depth perception loss due to reduction of visual acuity
b) Certain levels of astigmatism (above 1.00) are not compensated by the NVG
c) The weight of the goggles (28 ounces) rapidly causes pilot fatigue
d) All of the above are problems associated with NVGs

NH/NVG 50-Item Achievement Test

Answer Sheet

1. a b $\boxed{c}$ d
2. $\boxed{a}$ b c d
3. a $\boxed{b}$ c d
4. $\boxed{a}$ b c d
5. a b c $\boxed{d}$
6. a b c $\boxed{d}$
7. $\boxed{a}$ b c d
8. a $\boxed{b}$ c d
9. $\boxed{a}$ b c d
10. a b $\boxed{c}$ d
11. a $\boxed{b}$ c d
12. a b c $\boxed{d}$
13. a $\boxed{b}$ c d
14. a b c $\boxed{d}$
15. $\boxed{a}$ b c d
16. $\boxed{a}$ b c d
17. a b $\boxed{c}$ d
18. $\boxed{a}$ b c d
19. a $\boxed{b}$ c d
20. a b c $\boxed{d}$
21. a b $\boxed{c}$ d
22. a b $\boxed{c}$ d
23. a b c $\boxed{d}$
24. a b $\boxed{c}$ d
25. a $\boxed{b}$ c d
26. a b c $\boxed{d}$
27. T $\boxed{F}$
28. $\boxed{T}$ F
29. $\boxed{T}$ F
30. T $\boxed{F}$
31. $\boxed{T}$ F
32. T $\boxed{F}$
33. $\boxed{T}$ F
34. T $\boxed{F}$
35. $\boxed{T}$ F
36. T $\boxed{F}$
37. $\boxed{T}$ F
38. T $\boxed{F}$
39. T $\boxed{F}$
40. a b $\boxed{c}$ d
41. a b c $\boxed{d}$
42. $\boxed{a}$ b c d
43. a $\boxed{b}$ c d
44. a $\boxed{b}$ c d
45. a $\boxed{b}$ c d
46. $\boxed{a}$ b c d
47. a $\boxed{b}$ c d
48. a b c $\boxed{d}$
49. a b $\boxed{c}$ d
50. a b c $\boxed{d}$

APPENDIX C

MITANN COURSE OUTLINE

MITANN COURSE OUTLINE

TITLE	TIME	MATERIALS NEEDED
Night Terrain Interpretation	1 hour	2 slide trays
		2 slide projectors (1 with a rheostat)

PRACTICAL APPLICATION EXERCISES

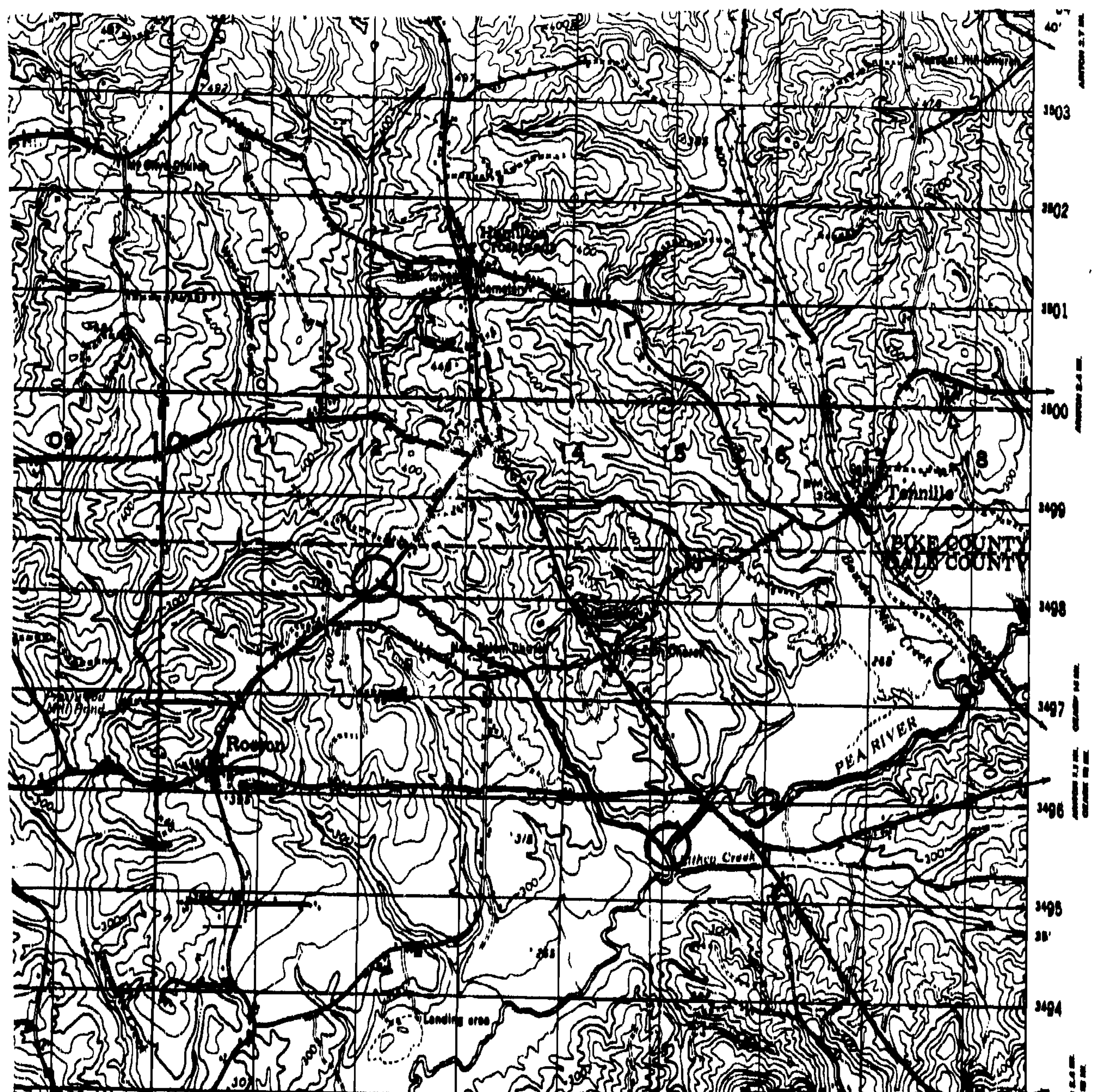
Terrain Analysis and Checkpoint Identification	1 hour	Route R-29 (unaided)
		Route H-10 (NVG)
		Handouts/Answer Sheets
		Map Plates
Cross Track Orientation	1 hour	Route K-1B Unaided/NVG
		Map Plates
Corridor Orientation	1 hour	Route HA-5B, Student 1: Unaided/NVG
		Route HA-5B, Second Half, Student 2: Unaided/NVG
		Map Plates
Track Testing	1 hour	Route K-6B Unaided
		Route K-5B NVG
		Map Plates

- -

Final Achievement Test	30 minutes	Test Booklets
Critique	20 minutes	Critique Booklets

APPENDIX D

MAP PLATE OF EXPERIMENTAL ROUTE



PIKE COUNTY
PEA RIVER
PEA RIVER
Tennille
Landing area
3503
3502
3501
3500
3499
3498
3497
3496
3495
3494
3493
3492
3491

APPENDIX E

FREQUENCY OF CRITIQUE RESPONSES

Frequency of Critique Responses

Key

STA	Strongly Agree
A	Agree
SA	Slightly Agree
SD	Slightly Disagree
D	Disagree
STD	Strongly Disagree
N/C	No Comment

	STA	A	SA	SD	D	STD	N/C
STUDY MATERIALS							
1. The Student Guide prepared me for the classroom instruction.	3	11					2
2. The reading assignments were relevant.	1	13					2
3. The time allotted to study this material was sufficient.	5	8			1		2
4. The reading assignments prepared me for the classroom instruction.	3	11					2
5. The Student Guide and related reading assignments aided me during the inflight test.	1	8	5				2
LECTURE MATERIALS							
6. During the Night Terrain Interpretation Course the night slides were effective.	2	9	4	1			
7. During the Night Terrain Interpretation Course the NVG slides were effective.	3	7	3	3			
8. The lecture material presented in the Night Terrain Interpretation Course section aided my performance during the inflight test.	4	5	6	1			

	STA	A	SA	SD	D	STD	N/C
9. The lecture on inflight communication was sufficient.	1	10	1		1		3
PRACTICAL APPLICATION EXERCISES							
10. The practical application exercise depicting unaided vision techniques for checkpoint identification aided me during the inflight test.	1	10	3	1			1
11. The practical application depicting checkpoint identification using NVGs aided me in the inflight test.	1	8	3	1			3
12. The practical application exercise depicting off-course plotting aided me during the inflight test.	1	5	9				1
13. The practical application exercise depicting course following aided me during the inflight test.	2	9	4	1			
OVERALL COURSE CONTENT							
14. The length of the course was about right.	2	7	3	1	1		2
15. The overall content of the course was effective in teaching me night navigation.	2	9	3	2			
16. The course provided me with enough information to fly the inflight mission successfully.	3	8	3	2			
17. The practical application movies looked realistic to me.	1	8	5	2			
18. I feel that I performed better on the inflight test as a result of the course.	4	9	2	1			
19. The test given during the course was relevant to what was taught during the course.	2	11	3				